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ABSTRACT

A project is reviewed which combined television, videotape and three dimensional computer graphics to provide new language experiences to deaf and hearing impaired children. The animation system is described in detail. Field testing in two schools was carried out with 52 students (7 to 15 years old). Ss demonstrated improvement in scores between pretest and posttest, with Ss exhibiting a high degree of interest in the videotapes. Appendixes include four videotape scripts and sample response sheets. (CL)

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FINAL REPORT

Auditorily Augmented Interactive Three-Dimensional Television as an Aid to Language Learning Among Deaf and Hearing Impaired Children

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March 1980

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INTRODUCTION

The ability to understand and to use language in all of its various expressive and receptive forms has long been a major requirement for success in the American school system. Severely handicapped children, such as deaf children, are frequently barred from regular education programs because of a failure to use and completely understand one or more forms of expressive or receptive language. Because they do not hear spoken Standard English, deaf children do not tend to develop the comprehensive language skills of listening, speaking, reading and writing at the same time or to the same degree of complexity as their hearing peer groups. Standard reading tests show that the average prelingually deaf adult reads at a level between the second and fourth grade, and that deaf children rarely exceed the fifth-grade reading level (Furth, 1973). Moreover, even these scores may indicate higher reading ability than deaf adults find functional. Studies using the "cloze procedure" requiring students to fill in blank grammatical frames (Moores, 1967), show that deaf students have great difficulty with these tasks.

Can changes in educational procedures and/or innovative materials change these achievement levels? Epstein (1976), in discussing the preliminary report of the American Institute for Research's 1.8 million dollar grant from the U.S. Office of Education to study the effects of innovation on education notes:

> The study found that second-graders given extra language skill instruction showed unusually large reading gains that year and the following one, and it suggested giving more attention to this approach.

In general, the study found little or no relation of innovation to increased scores on the Comprehensive Test of Basic Skills. It would be unwise to jump to

conclusions too rapidly from this study since the investigators pointed out the complex task involved in testing across school districts and state school systems. American education does not have established national curricula, programs, nor even established national standards. Most Federal programs provide broad guidelines rather than specific content and the major decisions for educational standards reside in state and local authorities. Therefore, it is significant that instruction on language skills in the early educational experiences of a student seems to have positive and lasting effects upon that student's ability to cope with the routine requirements of learning within school programs.

If it is important for children with normal development to have early and intensive programs designed to develop basic language skills, it is equally important for deaf children to have such programs. Over the past twenty years increased attention has been given to language development in both normal children and handicapped children by both psychologists and linguists. Chomsky (1959, 1965) provided a basis for the research and interest in these disciplines. Much of the early work centered in the acquisition of syntax and was a natural consequence of Chomsky's research. Current theories and research (Bloom, 1974; Clark, 1974; Slobin, 1973; Sinclair-deZwart, 1967) have emphasized the cognitive or conceptual development in the child in the language development process. Bloom emphasized that:

> Understanding and speaking do not develop separately with children learning different "rules" for each. Inasmuch as communication depends upon the extent to which the semantic intention of the speaker matches the semantic interpretation of the listener, the knowledge that each has could not be independent.....But, while it is most probably not the case that speaking and understanding are altogether separate developments, it is by no means clear that the emergence of speech and understanding shadow each other.

McNeill (1970) has hypothesized that from the beginning the child has the concept of sentence, and from the beginning all utterances of one word or more can be described as representing one or more of the grammatical relations of a sentence.

Nygren (1976) discussed the implications of this language theory for language-deficient children by noting that:

> "two capacities are necessary for learning language in the natural way. The child must have intact sensory mechanisms in order to receive the sound of the language and to experience the environment the language describes, and he or she needs the ability to generalize personal experience with language.
>
> The reason the handicapped child may not learn language spontaneously the way normal peers do is that the child lacks the sensory ability to generalize from the few critical examples of each language concept the natural situation provides.
>
> A young child who does not learn language spontaneously may appear to respond appropriately to spoken language. However, in this case the child may only be reading the situation or responding to a gesture. The question of careful assessment of the language knowledge of the child with deficient language is extremely important. While assessment goes on constantly when parents talk to young normal children, it is an informal and probably unconscious activity.
>
> For the language handicapped child, this assessment cannot be an unconscious activity. One must know how much the child is really responding to so as to provide for progress to the next level. The fact that the child will not be able to take that step independently is what distinguishes him or her from the normal child.

The ability of the infant to recall sensory experiences and to organize them into meaningful wholes is the beginning of the cognitive process. Early memory is based upon sensory experiences which are recalled through rich images that re-enact the past. Language is gradually associated with these experiences and eventually becomes the dominant form for conscious thought. Normally, a child learns to listen and then to speak. At a considerably later time he begins to

associate his listening and speaking skills with the development of reading, and writing is dependent upon a good development of receptive language.

Language referents are developed through exploration by the infant of his environment through taste, touch, movement, sight and sound. These sensory experiences are organized into concepts about the child's world and eventually associated with language symbols. In the early stages of this memory process the young child may recall past experiences as rich sensory images of the real event. This bank of sensory imagery eventually is reduced to cues which become signs and symbols for the child's world. Language becomes the shorthand for sensory images and the most common level of conscious thought.

Early educational opportunities must be provided deaf learners so that they can be encouraged to develop language skills which use the common symbols of their society. Although most deaf children have residual hearing, they are highly dependent on vision to provide most of the information for receptive communication of speech or of signs. Sherrick (1974) describes the use of one sensory system to handle the function of another system as metastatic techniques. He is cautious in his discussion of such systems and suggests that the following questions should be asked about the design and use of metastatic systems:

1. How good is the substitute sensory system in taking over a job usually performed by another sense and how effectively is the new signal assimilated with other sensory systems used by the handicapped person?
2. How is the substitute or transformed stimuli like the original stimuli?
3. How is the substitute sensory system different from the original system in its ability to handle stimuli?

These sensory substitutions may mean that deaf learners will have difficulty in achieving certain aspects of language skills. This does not mean that they are

not capable of developing comprehensive language skills, but it does mean that language development may be different for them and may require different educational techniques. One such technique for deaf children is an effective visual system augmented by appropriate auditory input.

It can be assumed that success in the American school system is dependent upon the ability of the learner to communicate. What are the communication processes and barriers of deafness to those processes? Communication can be defined as an individual's ability to publicly share private experiences. This assumes an ability to store experiences in a memory system and that such storage of experiences enables the individual to compare current with past sensory experiences. In the infant and young child these stored memories may be close to the original experiences and may be rich in visual, auditory, tactile and olfactory images paralleling the real world. The young child quickly associates clusters of experiences and reduces the clues required to be knowledgeable about a given event. These events become associated with the words and the syntax of a given language. The spoken word stands for the experience in the memory of the child.

Listening and speech skills become convenient storage units for memory and expression. During childhood the individual gradually replaces imagery with the arbitrary symbol systems of his/her language. By the time the hearing child is five years old he will have a workable knowledge of the syntax of his/her language. The kindergarten child will have associated a wide range of real life experiences with his/her language. The hearing child is bathed in an ocean of word experiences. Word experiences are defined as either hearing or speaking a word. Each year the hearing child has approximately 15,000,000 word experiences. If these estimates are correct, a child entering kindergarten will have had between 75,000,000 and

80,000,000 word experiences. These word experiences will vary in richness, complexity, and style depending upon the child's family and environment. A recent study by Brasel and Quigley (1977) emphasizes that the quality of the English language used by parents is a significant variable in the development of language by deaf children.

The age of mass communication has brought about a new era of word saturation. Each television station that broadcasts for twenty hours per day creates approximately 120,000 to 150,000 word experiences daily. Sesame Street and other children's television programs broadcast at the rate of about 5,000 words per hour. These word experiences differ from those experiences by young children in past generations. Television can be controlled to maximize the possibility of the association of words and language to their referents in real experiences. The average preschool child watches approximately 35 hours of television each week which means that he has 175,000 passive word experiences weekly and 63,875,000 televised word experiences each year.

Television and Language Development

More than 99 percent of all families in the United States have at least one television set. The fact of ownership means that the television set will be used and the average set is turned on about six and one-half hours each day. Children watch the television set because it is there and requires no special skills such as reading to use it. Bernstein (1976) reports that Down Syndrome children watching Sesame Street attend to and learn both cognitive and social skills from Sesame Street programs designed to model behavior. The segments studied were those in the 1975-1976 season when Down Syndrome children appeared on the Wednesday morning program. This effort was expanded in the 1976-1977 season.

Ambrosino (1975) explored the effect of television on self concepts in children. She reviewed the works of Schramm, Lyle and Parker (1961) and the Surgeon General's report (1972) on the impact of televised violence and found that:

> "the content of television is increasingly a source of language, information and socialization for the young. From the material on set, children see and imitate examples of pro- and anti-social behavior. And the more limited the child's "real" life experiences or his economic circumstances, the more likely he is to trust what he sees on the television screen. Greenberg (1972) and others have consistently found poor children and adults believing television far more than others and blacks believing it most of all. Some researchers have even postulated a vicarious use theory of viewing.

It is reasonable to assume that handicapped children are likely to have a limited "real" life experience which makes them more susceptible to the impact of television. They may use television as a vicarious experience to expand their "real" world and to compensate for their sensory loss. Television has a unique ability to manipulate time and space. As a learning experience, television can provide relations that can be used to enhance memory, to stop action and to associate language forms with events. Such common techniques as instant replay and stop action frames all act to expand memory. Liebergott and Swope (1976) reported on this aspect of television in the following manner:

> "The media have available unique characteristics for handling distancing between the child and the symbolic experience. An example of this is a segment from Sesame Street where a ball moves from a group of balls and is eaten by a fish. Initially, the fish is not a real fish, but two curved lines which touch in the beginning and cross at the end. After the ball is eaten by the fish, the camera moves in for a close-up on the curved lines. At this point, a real fish appears within the lines, and the camera moves back to reveal a group of fish swimming. For younger children, the appearance of the real fish may have narrowed the distance between themselves and the entire symbolic scene, so that they could now interpret the sequence."

This ability to interpose reality and symbolism has long been an asset of media formats and television techniques have expanded this ability to a practical level. It can be safely said that children watch television whether or not they fully understand the information available on the screen. This interest in television can be captured for educational purposes. Programming for deaf and hearing impaired children can be developed to provide language experiences that will assist in achieving mastery of English syntax and semantics.

Project Design

Educational materials were developed for this project which coordinated spoken and written language so that they interacted synergistically. The combination of television, videotape and the new technique of three-dimensional computer graphics was selected for this particular project on the basis of the flexibility offered by this medium to accomplish the special effects required to provide new language experiences for deaf and hearing impaired students. This combination of technologies allowed the materials designer to control time, space, color, movement and audition in a manner which emphasized specific linguistic principles.

Based on experimental work by Quigley, et al. (1976), relativization and prepositions indicating movement were selected as the language structures for instructional sequences. The studies of Russell, Quigley, and Power (1976) showed that many deaf and hearing impaired children had varying degrees of mastery of different linguistic principles and constructions of English when compared with normally hearing children of the same age. Language constructions which appeared to present difficulty to the deaf and hearing impaired student included those of prepositions and relative clauses.

During the first year of the project four 15 minute interactive 3/4 inch color videocassettes were developed. Three of the videocassettes addressed prepositional constructions and one videocassette addressed relative clause construction. In addition, 35mm slides were produced illustrating the same English language constructions and using the same computer generated graphics taken from the television screen and sequenced in the same manner as the video programs. All materials were designed to be used as either group or individualized learning experiences.

Formative evaluation was conducted during the development of each of the materials and informal pilot testing was done at the completion of each. During the second year of the project additional field testing was conducted with different populations in order to evaluate fully the instructional impact of the videotapes on the comprehension of the English language structures by deaf and hearing impaired students.

Specific information concerning the animation system employed, the process of materials design, the field tests and the results of those field tests can be found in the following sections of this report.

ANIMATION SYSTEM AND MATERIALS DEVELOPMENT

The materials that were developed for this project employed a unique three dimensional computer generated animation system developed by the Computer Graphics Research Group at the Ohio State University.

The Animation System

After more than three years of research, the Computer Graphics Research Group (CGRG) designed and implemented a unique three dimensional (3-D) computer animation system. This has become a practical production system based upon state of the art computer technology and specialized approaches to data representation and control.

ANIMA II is a computer animation system designed for the production of color, three-dimensional videotapes. It is aimed at the animator, educator and artist who require anything from a high volume of short color sequences for teaching purposes, to realistic key frame animation involving complex color objects and precisely timed lifelike movements. The ANIMA II system provides a flexible environment for the creation, animation and real-time playback display of color polyhedra. Animation sequences can be calculated with a turn-around time fast enough for constant previewing and easy editing.

The ANIMA II Language

The language of the ANIMA II system offers a means of imitating the complex motions of "real" world objects by breaking each motion into simple, but precisely controlled changes in space and time. Through a use written program or

script, the animator has a variety of key frame control over multiple objects, grouped or ungrouped. This control will involve smooth changes in motion, orientation, size, shape, color, lighting and perspective.

The animation language serves a system function of animating the multi-colored, multi-shaped, three-dimensional "solid" objects created using the interactive data generation techniques programmed by Richard Parent, and sending an animation file to a visible surface and color raster scan conversion routine based on the Myers algorithm. The output of the latter routine is a run-length encoded video file which can be played back in real time and in color, from a ten platter disk pack to a standard home TV.

The basic principle behind the programming language is that complex animation can be produced by sequential and simultaneous compounding of simple changes to the simple changes to the scene and to objects in the scene. A single scene directive can completely describe one change to one option. This includes the option type, the option parameters, the parametric limits, the response taken if its limits are reached, and the key frames of the change during the scene such as its beginning and end.

There are seven basic types of options which can be controlled by the scene directives in the script. These can affect the scene group, an object, or a group of objects.

1. Position - Objects can be set to any location in the scene cube inside or outside the displayable viewing area. Further, they may be pointed in a direction and given a motion speed, or the objects can be moved to a specified position in the space cube within a given time frame.
2. Rotation - All rotations taken place around the center of the scene cube, but because of the interpreting and compounding nature of the

language, an object can be spinning around its own axis, anywhere in space. Each rotation directive describes only one axis, so any rotation combination can be controlled.

3. Size - As with rotation, objects scale in size toward the cubic center, but can be moved to any scaling. Objects can be scaled up to several times their created size, or scaled down to a point and even total inversion.
4. Shape - An object has many possible shapes. Each shape is an exact structural copy of an original object. Only the vertice coordinate values are different. A scene directive says which shape the displayed object should change into, and how many steps it should take to complete the change. The key frame scheduling information controls the actual blending "in-between." It is not necessary to complete one change into a shape, before starting another. Blending can be stopped in progress and restarted toward a new shape from its current shape description. Simultaneous transmutations to several different shapes are also possible.
5. Path - An object or group of objects can tangentially follow a three-dimensional path through space. Path following is a convenient way of controlling motion, orientation and size. The path is a 3-D string of points made with a utility program in the data generation routines. A path directive parameter specifies how many points should be interpolated into the path. Each frame the object is moved to the location of the next point on the path. The object's orientation is determined by the direction of the next point from the current point. Perspective causes the object's size to change according to where the

point is in the Z axis. Scheduling information controls the actual path following activity.

6. Color - The color directives consist of:

   A. Changing the color (or one of the colors) of an object to another color. Color descriptions are given as palette section numbers from one to eight.

   B. The brightness or dimness of an object.

   C. Scheduling a fade in or a fade out to take place.

   D. Making an object one flat color, or coloring it with random colors.

   E. Background colors given as a red, green, blue number combination.

7. Light Source - Each object has its own point light source; also a group of objects, including the scene group, can share a common light source. The light sources can be moved to any position in the scene cube, as well as being rotated around the center. The relation between the polygonal face and the light source position determines which entry in the designated palette section will be used to color the face in the final sequence.

Set Change and Scheduling

In a key-frame animation environment, smooth motions are affected by gradual changes over successive frames. The speed of the motion is governed by the size of the change. Inherent in the process of animating a simple motion is the idea that an object is set to an initial position, rotation, or other transformation value, and then changed from that value to a new value. A set/change pair of scene directive affecting the same transformation option of an object describes one complete simple motion. From the end of, or during one motion, a new motion can begin and in this manner complex motions can be animated by compounding

sequential and simultaneous transformations.

Once the control parameters of a motion or action have been described, scheduling information is added to the scene directive. The basic form of the scheduling syntax is "from" a frame number, "to" a frame number. An object can thus be scheduled to change its rotation "from frame #1, to frame #200" or change its position "from frame #40 to frame #90." Variations of the syntax allow direct scheduling in seconds instead of frame numbers. When a scene directive has reached the end of its activeness, one of three things can happen.

1. The directive can stay active for the rest of the scene, but its parameters are left as they were at the end of the action.

2. The directive can be reset or ignored for the remainder of the scene.

3. The directive can be rescheduled for later activity. It will be inactive until its new start-up time and begin reinitialized. How often the directive repeats determines, in part, the rhythm of the animation sequence.

Once the animator has set the specifications describing the animation sequence, the computer system interprets his commands into a symbolic machine representation as pictures. These pictures are encoded and stored on a mass storage device. Ten seconds of animation require 300 individual pictures and when the sequence has been calculated, the final result can be played back and viewed on a standard color TV monitor. The final sequence is then recorded onto a color videotape.

Materials

Instructional Design

The language materials presented on the videotapes were designed to encourage interaction between the student and the instructional sequences.

The basic design for each of the instructional sequences was:

- the specified action
- the language appropriate to that action
- repeat of the action
- question for that action/language
- correct answers to the question

Each tape varied in the way these sequences were organized, but the basic pattern was retained. The following is a sample sequence:

ACTION
The whale swam through the pipe.
ACTION
Where did the whale swim?
ACTION - STOP ACTION ?
through the pipe
The whale swam through the pipe.

Scripts for each of the four tapes can be found in Appendix A.

The interactive response process was designed to be used in a variety of ways. One option lends itself to independent study. Response sheets were developed for each of the videotapes. The questions appropriate for each of the learning sequences for each videotape were written and at least two possible answers provided for each question. To respond the student matches the question on the response sheet to the question on the videotape and selects the answer he/she thinks is correct. Next, he/she checks the selected answer with the correct answer given on the videotape. Because there are many opportunities to see and respond to the same construction on each videotape, students can be encouraged to move ahead and not be overly concerned with wrong answers. Samples of these response sheets can be found in Appendix B. Other forms of response can be required depending on

teacher desires. If teachers wish to promote better oral or manual communication, students can respond orally or manually to the questions. Or students can be requested to write the answers with teachers stipulating that the response be a short answer or a full sentence.

Language Content

Three of the videotapes addressed the English language prepositional construction. The prepositions selected for the specific content of these videotapes were: on, off, into, through, over, across and around. These were chosen because they indicate motion, making them appropriate for animated sequences. Also, with the exception of on, these are prepositions that are frequently not mastered by even eighteen-year-old deaf students (Quigley, et al., 1976). The preposition on was included to provide contrast to the preposition off.

The fourth videotape was concerned with the relative clause construction. It was recognized that a single videotape addressing relative clauses was insufficient to encompass the difficulties of this language construction (Brasel and Quigley, 1977). Therefore, one placement was emphasized, with five of the six sequences employing medial relative clauses with one using final placement of the clause.

All of the verbs and most of the nouns used to illustrate the language constructions were familiar to most of the students. Pilot tests of the materials showed that the students readily learned any unfamiliar nouns and that the new nouns did not interfere with learning the intended message. This held true for the field tests also.

Humor was incorporated into the design of the materials. Some of the sequences deliberately used outrageous and impossible visual activities

to emphasize the language construction being presented. Students appeared to enjoy these sequences and to interact very positively.

Auditory Augmentation

These materials were designed to provide association of print and audition. All of the print language materials that appeared on the videotapes were accompanied by an auditory track. The entire message appeared on the screen and as the message was spoken, the phrases enlarged. This capability was possible because the print was also computer generated. The students could read and hear the message at the same time. This feature was intended for use by hearing impaired students, but could also be used by deaf students who had received intensive auditory training and found even minimal auditory signals helpful.

Unique Visuals

The objects and characters developed for the videotapes were very different from other kinds of instructional materials that the students had seen previously in books, films and television. The objects and characters were three-dimensional in appearance and at the same time had multifaceted surfaces appearing to reflect the light source in an unusual way. They were developed so that the students would readily recognize what the characters and objects were intended to represent. The colors selected for the characters were appropriate for that particular character, for example, the frog was green. The backgrounds were single contrasting colors so that the intended message was stressed. The characters animatedly illustrated the desired action -- shifting position, turning, dramatizing perspective, moving across, through, over and around objects and other characters.

Students appeared to respond positively to these images although there was no attempt to differenciate among the instructional organization, the content of the materials, and the visuals used.

FIELD TESTS

When the materials were completed, several questions were asked. How wide an age range would find these materials appealing? Would these materials be appropriate for deaf children with additional learning problems as well as children who were doing well in their learning environments? How much learning would occur with only one viewing of each videotape? Could the materials be used by teachers with a minimum of instruction?

Schools Selected

Two schools were selected for the field tests. The following characteristics determined the choice of School 1:

- total communication was the mode of instruction;
- primarily a residential program;
- student population included students with language learning problems in addition to deafness;
- student population included older students who had not yet mastered the prepositions in the materials.

School 2 had the following characteristics:

- oral communication was the mode of instruction;
- day school program;
- student population included students with language learning problems in addition to deafness;
- student population included younger students who understood prepositional constructions but who had not mastered the specific prepositions in the materials.

The populations of these two schools provided students who are representative of a wide variety of deaf students in school programs in the United States. The field

tests were not intended to contrast the achievements between the populations of the two schools. It was intended to determine how wide the appeal of the materials, if the materials were appropriate for students using different communication modes, if deaf students with additional learning problems could learn from the materials, and if teachers would find the materials easy to use.

Personnel

At School 1 the Language Coordinator was responsible for conducting the pretests and post-tests, for using the materials with individual students, and in helping teachers to use the materials with groups of students. At School 2 the Project Director was responsible for those same functions.

Pretest

The pretest was a paper and pencil test consisting of 32 sentences using prepositions and 5 sentences using relative clauses. The sentences using prepositions were multiple choice while the sentences using relative clauses required constructed answers. The prepositions were illustrated in comic strip fashion with four pictures. Under the four pictures were the subject and verb of the sentence with four possible prepositional phrases to complete the sentence. The student circled the prepositional phrase thought best to describe the action in the four pictures. Each sentence using relative clauses was followed by two questions to determine if the student understood the meaning of the sentence.

Students participated in the field tests if they missed three out of five correct answers for each of the prepositions and four out of ten of the questions for the sentences with the relative clauses.

Learning Activities

Each videotape was accompanied by a response sheet replicating the questions for each learning sequence on the videotape with at least two possible answers for each question using the prepositions of that particular videotape. Each student was given a response sheet and a heavy paper card. The card was used to reveal each question and possible answers as the sequence occurred on the videoscreen.

At School 1 the videotape materials were used in both individual and group situations. The older students were more likely to use the materials on an individual basis, while younger students used them in groups with teacher assistance. The differenciation was not dependent on age, but was related to upper class scheduling and to individual student need.

At School 2 all of the instructional activities took place in groups of five to eight students.

Post-test

After viewing and responding to the videotapes, the students were given the post-test. The content and procedures of the post-test were exactly the same as the pretest except that the individual prepositions were presented in a different order from the pretest order.

RESULTS AND DISCUSSION

A two-tailed paired t test was used to analyze the pretest/post-test data for the prepositional videotapes from the field tests. When all students were considered, results indicated a highly significant improvement in student scoring ($p. < .001$). See Table 1.

Table 2

Two-tailed Paired t Test of Scores for All Students

Test	Number of Students	Mean	S.D.	t Value	2-Tail Probability
Pretest	52	18.4808	7.785		
				-11.21	0.0000
Post-test	52	26.4808	4.413		

In fact, this improvement was so relevant and pervasive for the entire test application that specific differences of student samples did not show changes in this general trend. That is, when separate analyses were performed for each school in the study, pretest/post-test differences were again highly positive and showed significant pretest/post-test student development. See Table 2.

Table 2

Separate Two-tailed Paired t Test of Scores for School 1 and School 2 Students

	Number of Students	Mean	S.D.	t value	2-tail Probability
School 1					
Pretest	22	19.3182	7.441		
				-7.07	0.000
Post-test	22	27.5455	4.554		
School 2					
Pretest	30	17.8667	8.097		
				-8.60	0.000
Post-test	30	25.7000	4.211		

In examining the individual items on the pretest it would appear that students overall had little difficulty with the prepositions on, off and into, but exhibited a large degree of confusion with the prepositions across, through and around. After the videotape instructional sequences, however, this confusion appeared to be dimished. A simplified overview of the most dramatic instances of these instructional changes may be found in Tables 3 and 4. The reader should note that the frequences upon which the reported data on Tables 3 and 4 were based on those for complete matched pairs of data sets. Use of the total number of respondents for these comparisons would provide misleading information.

TABLE 3

Pretest/Post-test Changes for Three Selected Prepositions by School I Students

Count Row % Col. % Total %	Pretest	Post-test	Row Total	Count Row % Col. % Total %	Pretest	Post-test	Row Total	Count Row % Col. % Total %	Pretest	Post-test	Row Total
*across	8 34.8 36.4 18.2	15 65.2 68.2 34.1	23 52.3	off	4 66.7 18.2 9.1	2 33.3 9.1 4.5	6 13.7	between	2 100.0 9.1 4.5	0 0 0 0	2 4.5
under	0 0 0 0	1 100.0 4.5 2.3	1 2.3	*through	13 44.8 59.1 29.5	16 55.2 72.7 36.4	29 65.9	behind	7 87.5 31.8 15.9	1 12.5 4.5 2.3	8 18.2
through	7 70.0 31.8 15.9	3 30.0 13.6 6.8	10 22.7	around	0 0 0 0	2 100.0 9.1 4.5	2 4.5	across	2 50.0 9.1 4.5	2 50.0 9.1 4.5	4 9.1
around	7 70.0 31.8 15.9	3 30.0 13.6 6.8	10 22.7	between	5 71.4 22.7 11.4	2 28.6 9.1 4.5	7 15.9	*through	11 36.7 50.0 25.0	19 63.3 86.4 43.2	30 68.2
Column Total	22 50.0	22 50.0	44 100.0	Column Total	22 50.0	22 50.0	44 100.0	Column Total	22 50.0	22 50.0	44 100.0

* Correct Response

TABLE 4

Pretest/Post-test Changes for Three Selected Prepositions by School 2 Students

Count Row % Col. % Total %	Pretest	Post-test	Row Total	Count Row % Col. % Total %	Pretest	Post-test	Row Total	Count Row % Col. % Total %	Pretest	Post-test	Row Total
*across	14 41.2 48.3 23.7	20 58.8 66.7 33.9	34 57.6	off	7 70.0 23.3 11.7	3 30.0 10.0 5.0	10 16.7	between	2 100.0 6.7 3.3	0 0 0 0	2 3.3
under	1 33.3 3.4 1.7	2 66.7 6.7 3.4	3 5.1	*through	11 35.5 36.7 18.3	20 64.5 66.7 33.3	31 51.7	behind	3 100.0 10.0 5.0	0 0 0 0	3 5.0
through	9 52.9 31.0 15.3	8 47.1 26.7 13.6	17 28.8	around	2 66.7 6.7 3.3	1 33.3 3.3 1.7	3 5.0	across	6 75.0 20.0 9.8	2 25.0 6.5 3.3	8 13.1
around	5 100.0 17.2 8.5	0 0 0 0	5 8.5	between	10 62.5 33.3 16.7	6 37.5 20.0 10.0	16 26.7	*through	19 40.4 63.3 31.1	28 59.6 90.3 45.9	47 77.0
Column Total	29 49.2	30 50.8	59 100.0	Column Total	30 50.0	30 50.0	60 100.0	Column Total	30 50.0	30 50.0	60 100.0

* Correct Response

The pretest/post-test data related to the videotape addressing relative clause construction did not show the same positive gains as those of the tapes addressing prepositional construction. The data did not lend itself to statistical analysis, but examination of the tests themselves demonstrated that a single exposure to that videotape did not result in positive changes in student ability to construct correct answers to questions related to a sentence with a relative clause.

Discussion

As shown in Table 1, the field test student population as a whole demonstrated a striking positive change as measured by the pretest/post-test data. This population ranged in age from seven to fifteen, represented different instructional communication modes, and included students who had additional language learning problems. Characteristics for each of the schools can be found on page 19. This change was so positive that the data from each school was examined separately.

It is clear from Table 2 that students from both School 1 and School 2 demonstrated improvement in scores between pretest and post-test. It is of special interest that all but two students in the study achieved this dramatic improvement with only one viewing of the prepositional videotapes. (For reference see Field Testing, Learning Activities)

Students exhibited a high degree of interest in the format of the videotapes, identifying each of the computer generated animation creatures by name. This was especially true of students between the ages of seven and eleven. In general, students between the ages of twelve and fifteen tended to find the materials less stimulating. Since the materials were designed for an interest level of students between the ages of eight and eleven, it is not surprising that older students might

find the material content too young for them although the pretest indicated that the specific prepositions utilized were those that they had not yet mastered.

The materials were designed to elicit responses from the students for each of the segments of action. When this design was introduced to the students, many had some difficulty when they made an incorrect selection and required encouragement to proceed to the next segment. Within two or three segments, however, they appeared to enjoy the challenge and became excited when they made the correct response without becoming upset when they selected a wrong answer. It would seem that correct responses are intrinsically rewarding in themselves to even young learners.

Comments from both students and teachers regarding the coordinated spoken and written language demonstrate diametrically opposed opinions. Students who had had long-term, early, successful auditory training experiences found the auditorily augmented language materials beneficial. In fact, if, for some reason they could not hear the auditory portion of the videotape, they asked to have the volume turned up. It would appear that although these profoundly deaf children cannot understand auditory speech even with amplification, they do obtain information about speech patterns which aid in language acquisition. On the other hand, students who had not had successful auditory training experiences in the past found that the auditory signals tended to interfere with the learning process. Teachers of these students turned the sound off when showing the tapes. One or two of the teachers suggested that the materials be issued in two formats, one with sound and one without. It should be noted, however, that regardless of auditory input preference, student performance was improved dramatically between pretest and post-test.

The total list of prepositions selected for these procedures were: on, off, into, through, over, across, and around. Additional information regarding the process for the selection of these particular prepositions can be found in Materials Development, Language Content, page 16. For most of the students as shown by the pretest, the preposition on, off and into had some familiarity, but those of through, over, across and around had not been encountered previously or were confusing. A single application of the videotape instructional materials resulted in a diminishing of the confusion as can be seen by examining Tables 3 and 4.

The dramatic positive changes in student performance for a single viewing of the prepositional instructional materials did not hold for a single viewing of the more difficult language construction for medially placed relative clauses. On the pretest/post-test and on the response sheets, the students were required to construct the answers to the questions. This differed from the prepositional materials and was much more difficult to execute. It may be that six sequences for this complex construction may not be adequate to achieve the desired learning for deaf students and may require several viewings or, indeed, may require additional instructional sequences. Parenthetically, upon viewing this videotape, a Japanese businessman stated, "For the first time, I understand what that sentence structure means."

It may also be that the structure of the response required for the relative clause material may be too difficult for students trying to learn this construction. Redesign of the response format could possibly assist students in recognizing the components of the sentence containing a relative clause.

In summary, a single viewing of the interactive prepositional videotapes produced a dramatic positive change between pretest and post-test for the student

population as a whole from seven to fifteen years of age. This held true regardless of the instructional communication mode. However, this positive change for a single viewing was not evident for the relative clause videotape. It may be that this language construction is too difficult for deaf students to learn the sentence components with only six instructional sequences and may require either multiple viewings or additional instructional sequences. Students between the ages of seven and eleven found the materials especially interesting and enthusiastically responded to the interactive format.

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APPENDICES

APPENDIX A

Videotape Scripts

TAPE I

Across and Around

ACTION - Penguin introduces the elephant, the kangaroo, the woman and the man, a river and a boat

ACTION
The man rowed the boat across the river.
ACTION
Where did the man row the boat?
ACTION - STOP ACTION ?
across the river
The man rowed the boat across the river.

ACTION
The kangaroo rowed the boat across the river.
ACTION
Where did the kangaroo row the boat?
ACTION - STOP ACTION ?
across the river
The kangaroo rowed the boat across the river.

ACTION
The elephant rowed the boat across the river.
ACTION
Where did the elephant row the boat?
ACTION - STOP ACTION ?
across the river
The elephant rowed the boat across the river.

ACTION - Penguin introduces the bridge

ACTION
The woman walked across the bridge.
ACTION
Where did the woman walk?
ACTION - STOP ACTION ?
across the bridge
The woman walked across the bridge.

ACTION
The man walked across the bridge.
ACTION
Where did the man walk?
ACTION - STOP ACTION ?
across the bridge
The man walked across the bridge.

ACTION
The kangaroo hopped across the bridge.
ACTION
Where did the kangaroo hop?
ACTION - STOP ACTION ?
across the bridge
The kangaroo hopped across the bridge.

ACTION - Penguin introduces the rocking chair

ACTION
The elephant walked around the rocking chair.
ACTION
Where did the elephant walk?
ACTION - STOP ACTION ?
around the walking chair
The elephant walked around the rocking chair.

ACTION
The kangaroo hopped around the rocking chair.
ACTION
Where did the kangaroo hop?
ACTION - STOP ACTION ?
around the rocking chair
The kangaroo hopped around the rocking chair.

ACTION
The woman walked around the rocking chair.
ACTION
Where did the woman walk?
ACTION - STOP ACTION ?
around the rocking chair
The woman walked around the rocking chair.

ACTION - Penguin introduces the balloon

ACTION
The man flew around the balloon.
ACTION
Where did the man fly?
ACTION - STOP ACTION ?
around the balloon
The man flew around the balloon.

ACTION
The kangaroo flew around the balloon.
ACTION
Where did the kangaroo fly?
ACTION - STOP ACTION ?
around the balloon
The kangaroo flew around the balloon.

ACTION
The elephant flew around the balloon.
ACTION
Where did the elephant fly?
ACTION - STOP ACTION ?
around the balloon
The elephant flew around the balloon.

ACTION
The kangaroo rowed the boat across the river.
ACTION
Where did the kangaroo row?
ACTION - STOP ACTION ?
The kangaroo rowed the boat across the river.

ACTION
The man walked across the bridge.
ACTION
Where did the man walk?
ACTION - STOP WALK ?
across the bridge
The man walked across the bridge.

ACTION
The woman walked around the rocking chair.
ACTION
Where did the woman walk?
ACTION - STOP ACTION ?
around the rocking chair
The woman walked around the rocking chair.

ACTION
The elephant flew around the balloon.
ACTION
Where did the elephant fly?
ACTION - STOP ACTION ?
around the balloon
The elephant flew around the balloon.

TAPE II

On and Off at the Circus

ACTION - Complete circus sequence

The clown jumped off the platform.
ACTION
Where did the clown jump?
off the platform
The clown jumped off the platform.

The clown fell into the bucket.
ACTION
Where did the clown fall?
into the bucket
The clown fell into the bucket.

The rabbit hopped off the see-saw.
ACTION
off the see-saw
The rabbit hopped off the see-saw.

The rabbit dropped into the cannon.
ACTION
Where did the rabbit drop?
into the cannon
The rabbit dropped into the cannon.

The rabbit shot out of the cannon.
ACTION
Where did the rabbit shoot?
out of the cannon
The rabbit shot out of the cannon.

The rabbit knocked the bear off the trapeze.
ACTION
Where did the rabbit knock the bear?
off the trapeze
The rabbit knocked the bear off the trapeze.

The bear fell on the trampoline.
ACTION
Where did the bear fall?
on the trampoline
The bear fell on the trampoline.

The bear bounced off the trampoline.
ACTION
Where did the bear bounce?
off the trampoline
The bear bounced off the trampoline.

The bear landed on the tightrope
ACTION
Where did the bear land?
on the tightrope
The bear landed on the tightrope.

The bear bounced the kangaroo off the tightrope.
ACTION
Where did the bear bounce the kangaroo?
off the tightrope
The bear bounced the kangaroo off the tightrope.

The kangaroo dropped into the car.
ACTION
Where did the kangaroo drop?
into the car
The kangaroo dropped into the car.

The car bumped into the ladder.
ACTION
Into the ladder
The car bumped into the ladder.

The bird bounced off the ladder and onto the drums.
ACTION
Where did the bird bounce?
off the ladder and onto the drums
The bird bounced off the ladder and onto the drums.

The bird flew into the hat.
ACTION
Where did the bird fly?
into the hat
The bird flew into the hat.

TAPE III

Through and Over

ACTION
The whale swam through the pipe.
ACTION
Where did the whale swim?
ACTION - STOP ACTION ?
through the pipe
The whale swam through the pipe.

ACTION
The duck walked through the flowers.
ACTION
Where did the duck walk?
ACTION - STOP ACTION ?
through the flowers
The duck walked through the flowers.

ACTION
The car drove through the fence.
ACTION
Where did the car drive?
ACTION - STOP ACTION ?
through the fence
The car drove through the fence.

ACTION
The frog jumped through the hoop.
ACTION
Where did the frog jump?
ACTION - STOP ACTION ?
through the hoop
The frog jumped through the hoop.

ACTION
The airplane flew through the barn.
ACTION
Where did the airplane fly?
ACTION - STOP ACTION ?
through the barn
The airplane flew through the barn.

ACTION
The bird flew through the window.
ACTION
Where did the bird fly?
ACTION - STOP ACTION ?
through the window
The bird flew through the window.

ACTION
Did the whale swim through the pipe?
ACTION - STOP ACTION ?
Yes, the whale swam through the pipe.

ACTION
Did the frog jump over the hoop?
ACTION - STOP ACTION ?
No, the frog jumped through the hoop.

ACTION
Did the car drive over the ball?
ACTION - STOP ACTION ?
Yes, the car drove over the ball.

ACTION
Did the bird fly through the window?
ACTION - STOP ACTION ?
No, the bird flew over the roof.

ACTION
Did the duck walk over the rock
ACTION - STOP ACTION ?
No, the duck walked thorugh the flowers.

ACTION
did the airplane fly through the barn?
ACTION - STOP ACTION ?
Yes, the airplane flew through the barn.

ACTION
Did the car drive through the fence?
ACTION - STOP ACTION ?
Yes, the car drove through the fence.

ACTION
Did the whale swim through the pipe?
ACTION - STOP ACTION ?
No, the whale swam over the pipe.

ACTION
Did the frog jump over the hoop?
ACTION - STOP ACTION ?
Yes, the frog jumped over the hoop.

ACTION
Did the airplane fly through the barn?
ACTION - STOP ACTION ?
No, the airplane flew over the barn.

ACTION
Did the duck walk over the rock?
ACTION - STOP ACTION ?
Yes, the duck walked over the rock.

ACTION
The whale swam over the pipe.
ACTION
Where did the whale swim?
ACTION - STOP ACTION ?
over the pipe
The whale swam over the pipe.

ACTION
The duck walked over the rock.
ACTION
Where did the duck walk?
ACTION - STOP ACTION ?
over the rock
The duck walked over the rock.

ACTION
The car drove over the ball.
ACTION
Where did the car drive?
ACTION - STOP ACTION ?
over the ball
The car drove over the ball.

ACTION
The frog jumped over the hoop.
ACTION
Where did the frog jump?
ACTION - STOP ACTION ?
over the hoop
The frog jumped over the hoop.

ACTION
The airplane flew over the barn.
ACTION
Where did the airplane fly?
ACTION - STOP ACTION ?
over the barn
The airplane flew over the barn.

ACTION
The bird flew over the roof.
ACTION
Where did the bird fly?
ACTION - STOP ACTION ?
over the roof
The bird flew over the roof.

TAPE IV

The Magician and His Relative Clauses

CURTAIN OPENS

ACTION
The magician who was behind the curtain will do some more tricks.
ACTION - STOP ACTION ?
Where was the magician?
behind the curtain
The magician was behind the curtain.
What will he do?
some more tricks
The magician will do some more tricks.

ACTION
The red rabbit which came from the hat bounced on the floor.
ACTION - STOP ACTION ?
Where did the red rabbit come from?
from the hat
The red rabbit came from the hat.
Where did the red rabbit bounce?
on the floor
The red rabbit bounced on the floor.

ACTION
The flower which is in the magician's hand is yellow.
ACTION - STOP ACTION ?
Where is the flower?
in the magician's hand
The flower is in the magician's hand.
What color is the flower?
yellow
The flower is yellow.

ACTION
The bears which were on the balls rolled across the floor.
ACTION - STOP ACTION
Where were the bears?
on the balls
The bears were on the balls.
Where did the bears roll?
across the floor
The bears rolled across the floor.

ACTION
The bird which landed on the wand can fly up, down and all around.
ACTION - STOP ACTION ?
Where did the bird land?
on the wand
The bird landed on the wand.
What can the bird do?
fly up, down and all around
The bird can fly up, down and all around.

ACTION
The bird flew the plane that went around the wand and around and over the magician.
ACTION - STOP ACTION ?
What did the bird fly?
the plane
The bird flew the plane.
Where did the plane go?
around the wand and around and over the magician
The plane went around the wand and around and over the magician.

APPENDIX B

Sample Response Sheet

ACROSS AND AROUND

Where did the man row the boat?

a. around the river

b. across the river

Where did the kangaroo row the boat?

a. across the river

b. around the river

Where did the elephant row the boat?

a. across the river

b. around the river

Where did the woman walk?

a. across the bridge

b. around the bridge

Where did the man walk?

a. around the bridge

b. across the bridge

Where did the kangaroo hop?

a. across the bridge

b. around the bridge

Where did the elephant walk?

a. across the rocking chair

b. around the rocking chair

Where did the kangaroo hop?

a. around the rocking chair

b. across the rocking chair

Where did the woman walk?

a. around the rocking chair

b. across the rocking chair

Where did the man fly?

a. around the balloon

b. across the balloon

Where did the kangaroo fly?

a. around the balloon

b. across the balloon

Where did the elephant fly?

a. across the balloon

b. around the balloon

Where did the kangaroo row?

a. around the river

b. across the river

Where did the man walk?

a. around the bridge

b. across the bridge

Where did the woman walk?

a. around the rocking chair

b. across the rocking chair

Where did the elephant fly?

a. around the balloon

b. across the balloon

ON AND OFF AT THE CIRCUS

Where did the clown jump?

a. on the platform

b. into the platform

c. off the platform

Where did the clown fall?

a. off the bucket

b. into the bucket

c. on the bucket

Where did the rabbit hop?

a. off the see-saw

b. on the see-saw

c. into the see-saw

Where did the rabbit drop?

a. off the cannon

b. into the cannon

c. onto the cannon

Where did the rabbit shoot?

a. into the cannon

b. out of the cannon

c. off the cannon

Where did the rabbit knock the bear?

a. onto the trapeze

b. off the trapeze

c. on the trapeze

Where did the bear fall?

a. on the trampoline

b. off the trampoline

c. out of the trampoline

Where did the bear bounce?

a. into the trampoline

b. off the trampoline

c. on the trampoline

Where did the bear land?

a. off the tightrope

b. into the tightrope

c. on the tightrope

Where did the bear bounce the kangaroo?

a. on the tightrope

b. off the tightrope

c. into the tightrope

Where did the kangaroo drop?

a. into the car

b. on the car

c. off the car

Where did the car bump?

a. off the ladder

b. on the ladder

c. into the ladder

Where did the bird bounce?

a. off the ladder and onto the drums

b. on the ladder and into the drums

c. in the ladder and off the drums

Where did the bird fly?

a. on the hat

b. into the hat

c. off the hat

THROUGH AND OVER

Where did the whale swim?

a. over the pipe

b. through the pipe

Where did the duck walk?

a. through the flowers

b. over the flowers

Where did the car drive?

a. through the fence

b. over the fence

Where did the frog jump?

a. through the hoop

b. over the hoop

Where did the airplane fly?

a. over the barn

b. through the barn

Where did the bird fly?

a. over the window

b. through the window

Where did the whale swim?

a. over the pipe

b. through the pipe

Where did the duck walk?

a. through the rock

b. over the rock

Where did the car drive?

a. over the ball

b. through the ball

Where did the frog jump?

a. through the hoop

b. over the hoop

Where did the airplane fly?

a. over the barn

b. through the barn

Where did the bird fly?

a. over the roof

b. through the roof

Did the whale swim through the pipe?

a. Yes, the whale swam through the pipe.

b. No, the whale swam over the pipe.

Did the frog jump over the hoop?

a. Yes, the frog jumped over the hoop.

b. No, the frog jumped thorugh the hoop.

Did the car drive over the ball?

a. Yes, the car drove over the ball.

b. No, the car drove through the fence.

Did the bird fly through the window?

a. Yes, the bird flew through the window.

b. No, the bird flew over the roof.

Did the duck walk over the rock?

a. Yes, the duck walked over the rock.

b. No, the duck walked through the flowers.

Did the airplane fly through the barn?

a. Yes, the airplane flew through the barn.

b. No, the airplane flew over the barn.

Did the car drive thorugh the fence?

a. Yes, the car drove through the fence.

b. No, the car drove over the ball.

Did the whale swim through the pipe?

a. Yes, the whale swam through the pipe.

b. No, the whale swam over the pipe.

Did the bird fly over the roof?

a. Yes, the bird flew over the roof.

b. No, the bird flew through the window.

Did the frog jump over the hoop?

a. Yes, the frog jumped over the hoop.

b. No, the frog jumped through the hoop.

Did the airplane fly through the barn?

a. Yes, the airplane flew through the barn.

b. No, the airplane flew over the barn.

Did the duck walk over the rock?

a. Yes, the duck walked over the rock.

b. No, the duck walked through the flowers.

THE MAGICIAN AND HIS RELATIVE CLAUSES

The magician who was behind the curtain will do some more tricks.

Where was the magician?

What will he do?

The red rabbit which came from the hat bounced on the floor.

Where did the red rabbit come from?

Where did the red rabbit bounce?

The flower which is in the magician's hand is yellow.

Where is the flower?

What color is the flower?

The bears which were on the balls rolled across the floor.

Where were the bears?

Where did the bears roll?

The bird which landed on the wand can fly up, down and all around.

Where did the bird land?

What can the bird do?

The bird flew the plane that went around the wand and around and over the magician.

What did the bird fly?

Where did the plane go?